

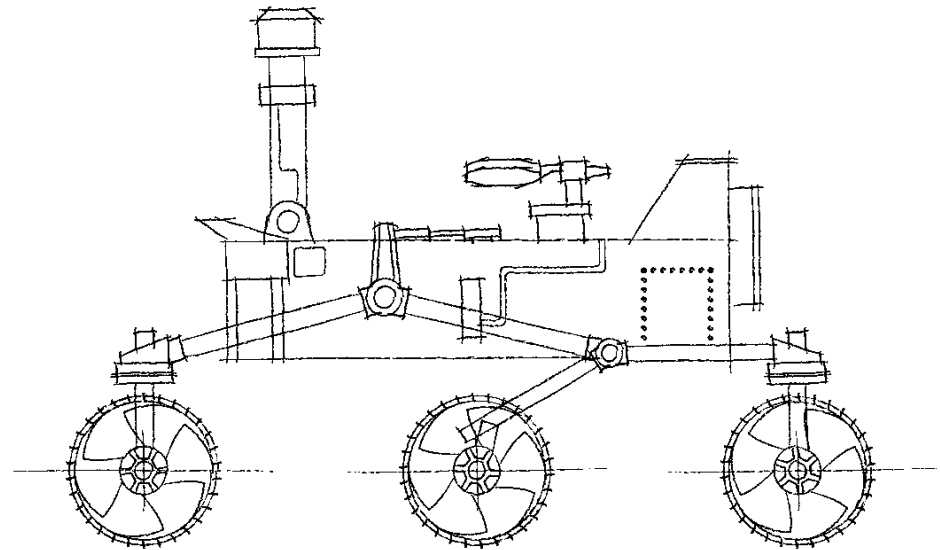
# Mars 2020 Project

Mars Exploration Program Advisory Group

McNamee/Farley

Mars 2020 Project Team

March 3, 2016



**Mars 2020 Project**

A new type of planetary mission in which  
***exploration supports sampling***

# MARS ROVER EVOLUTION



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**Sojourner:** *bulk geochemistry, no sampling*

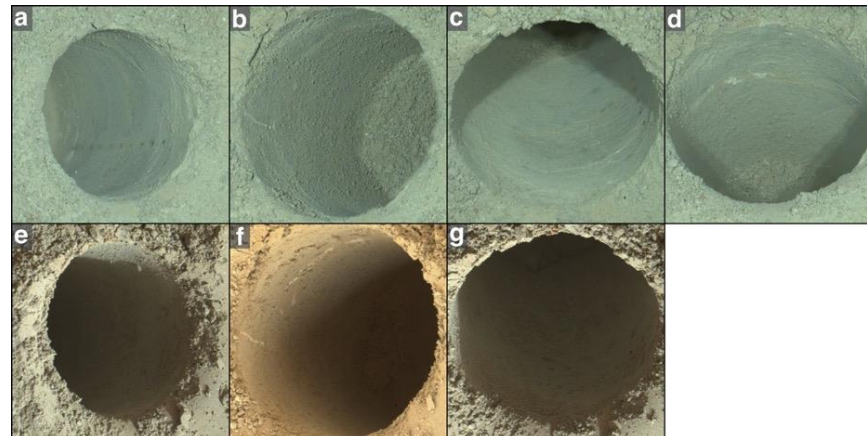


**MER:** *abrasion + bulk geochemistry*



**MSL:** *powder drilling + bulk geochemistry*

Sampling supporting  
exploration...

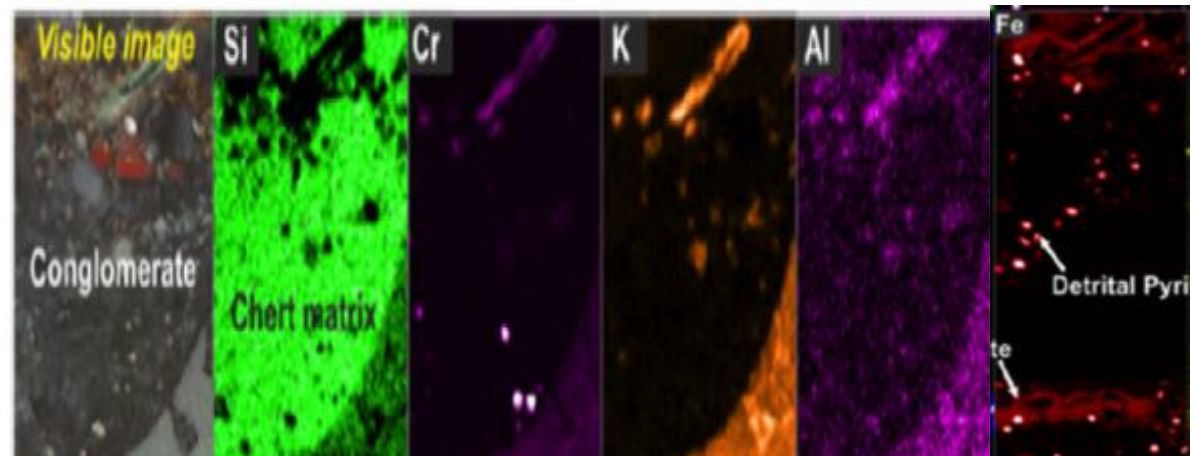
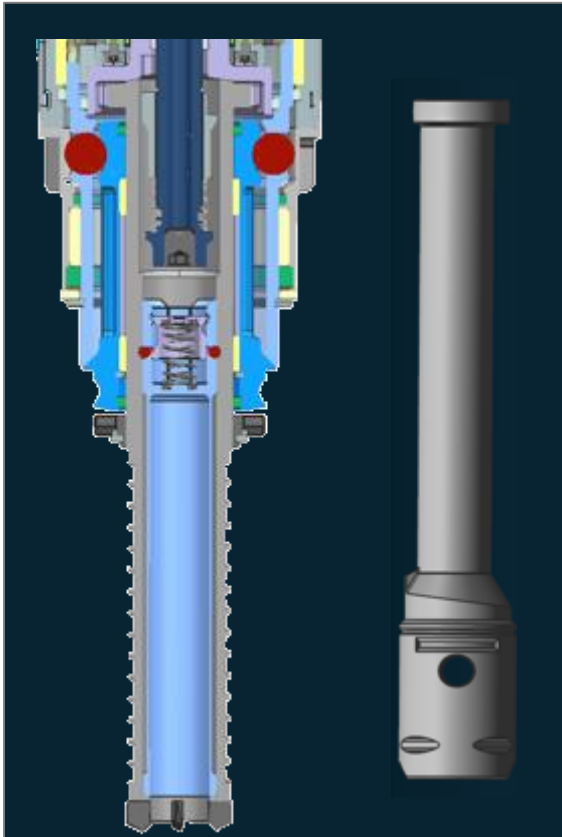
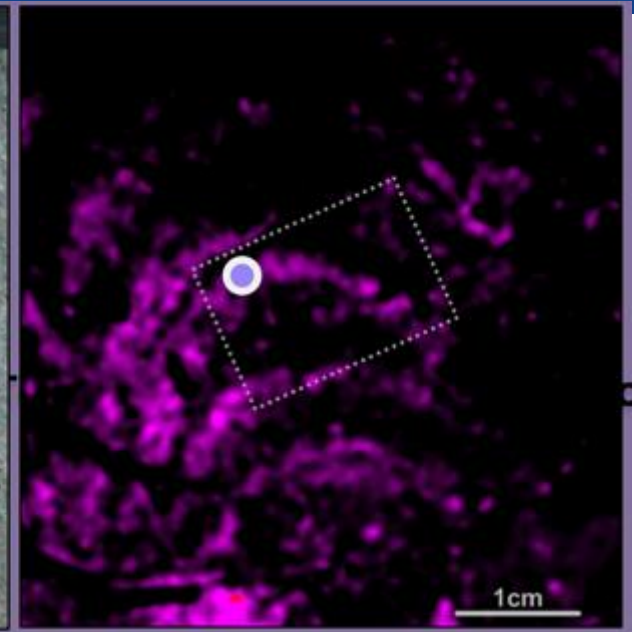


# MARS 2020: *coring/caching* + spatially resolved geochemistry



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MSL exploration + \*Mars Sample Return  
with the same rover and a lower budget

We will use our payload to explore a new region of Mars,  
and to support the selection of samples that,  
*if successfully returned to Earth,*  
**would provide material for generations**  
**of planetary scientists.**

# What Mars 2020 science is...



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For previous (and existing) Mars rover missions,  
*sampling supported exploration.*

For Mars 2020, the first step towards \*Mars sample return,  
***exploration supports sampling.***

*This transition is analogous to the evolution of terrestrial  
geological/geochemical investigations as knowledge of the  
study area grows*

We must strive to maximize operational efficiencies using innovative and strategic approaches wherever possible.

But... *some of the scientific process is incompressible.*

As we approach a target  
(e.g. orbital data > remote science > proximity science),  
*information increases, and interpretations evolve*

The science team must arrive at Mars highly trained, nimble, and disciplined - ready to support extremely rapid data generation and dissemination, and

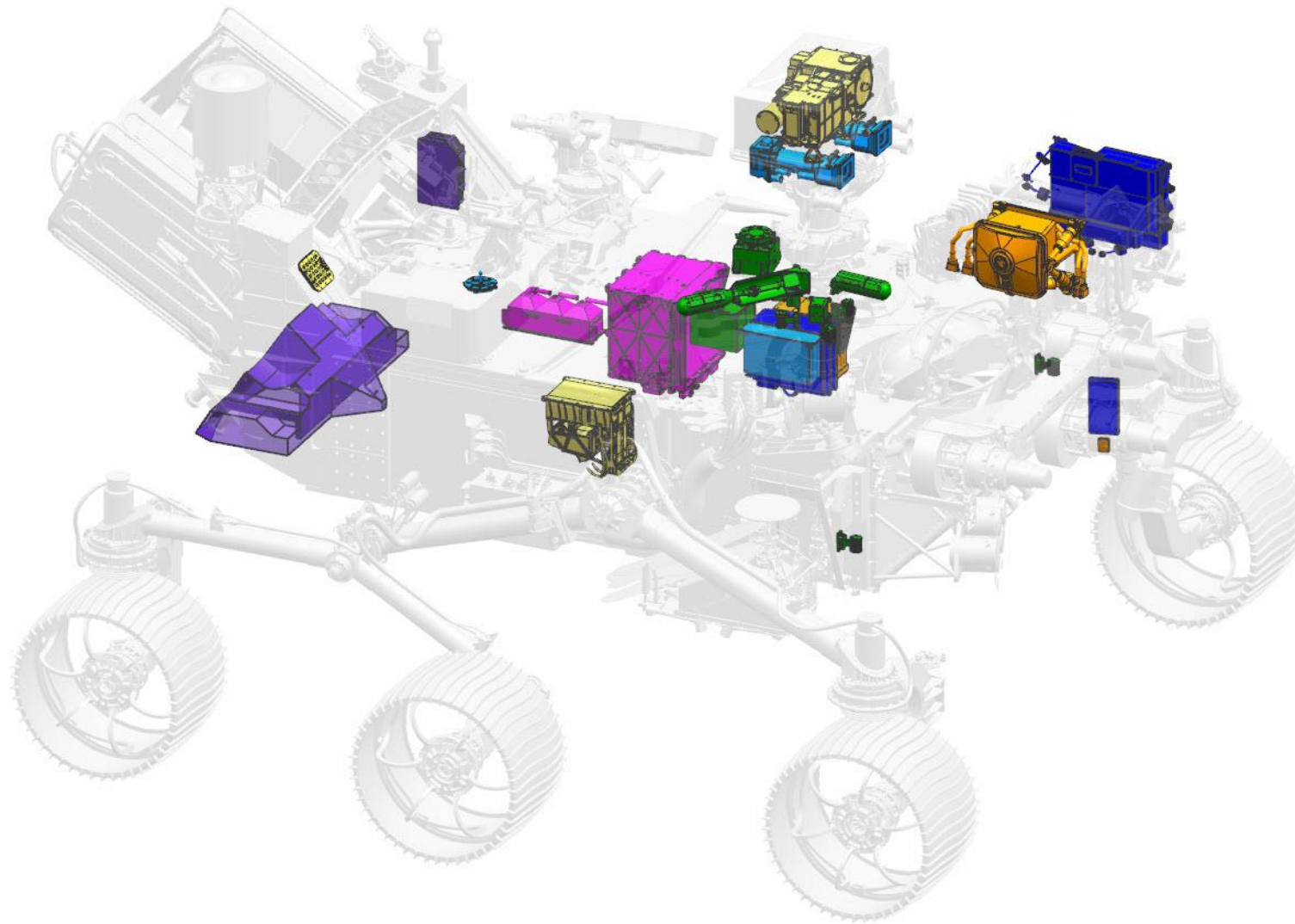
*ready to make hard decisions quickly.*

# Mars 2020 Payload Family Picture



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Instrument Key
<b>Mastcam-Z</b> Stereo Imager
<b>MEDA</b> Mars Environmental Measurement
<b>MOXIE</b> In-Situ Oxygen Production
<b>PIXL</b> Microfocus X-ray fluorescence spectrometer
<b>RIMFAX</b> Ground Penetrating Radar
<b>SHERLOC</b> Fluorescence and Raman spectrometer and Visible context imaging
<b>SuperCam</b> LIBS and Raman

## What is required to obtain a sample collection scientifically worthy of return to Earth?

Requirements derived through consultation with science community including:

- previously published documents focused on Mars Sample Return
  - especially the MEPAG publication **e2e-iSAG** (2011)
- ad hoc MPO Returned Sample Science working group (2013-2015)
  - predecessor of Returned Sample Science (RSS) Board
- HQ-chartered **Organic Contamination Panel** (OCP, 2014)
  - published report 2014
- HQ-chartered **Returned Sample Science Board** (2015-)
  - *board chair is a member of the Mars 2020 Project Science Group*
- consultation with JSC Curation (2015-)
  - Dr. Francis McCubbin, Mars Curator at JSC; also member of RSSB

# Sample Integrity Requirements



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1. Physical characteristics of samples and environments
  - Sample mass, number of samples, fracture limits, environmental requirements
2. Inorganic contaminants
  - Limitations on levels of ~20 elements critical for scientific study of samples
3. Organic contaminants
  - Total organic carbon + critical “Tier 1” list + limit on any single compound
4. Biologic contamination
  - a) tightly limit the number of cells per sample
  - b) collect thorough genetic inventory and contaminant archive to facilitate recognition of any terrestrial hitchhikers
5. Thorough characterization and archiving of materials which may add inorganic, organic, or biologic contamination to samples
6. Procedural blank program to characterize inorganic, organic, and biologic contamination occurring at and after ATLO (round-trip contamination)

# Sample Integrity Requirements



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7. Thorough documentation of geology of landing site and drilled sample context
  - critical linkage to the in-situ investigation
  - context-rich samples are of far greater value than “grab” samples

## 1. Forward Contamination

(prevent contamination of Mars by terrestrial viable organisms)

- Mars 2020 has a high heritage strategy based on successful MSL cleaning approach and will not target known Special Region

*This is not controversial nor problematic*

## 2. Backward Contamination

(prevent contamination of Earth by possible Martian organisms)

- Mars 2020 has a limited role in this aspect of planetary protection
- Backward contamination control (“break the chain”) will primarily be the responsibility of future possible missions

*This is not controversial nor problematic*

## 3. Science Integrity

(Ensure that life-related\* investigations *in-situ* on Mars and on possible returned samples on Earth can be successfully conducted)

- maintaining scientific integrity of *in-situ* investigations and of possible returned samples is of paramount importance to the Mars 2020 project. It is the rationale for doing the mission.

- broadly speaking, responsibility for the the scientific success of a mission rests with the science community, the mission science team, the project science group, and the project science office.

\*how shall this word be interpreted?

1. Mars 2020 Team Guidelines adopted
  - similar to MSL's "Rules of the Road" but with a greater emphasis on open communication with external science community and the public
2. Brush capability descoped
  - Mars 2020 instruments PIXL, SHERLOC *are safer and perform better* on a flat, dust-free, abraded surface
  - bushing no simpler/faster than abrading
  - no unrecoverable science loss
  - sampling and caching system complexity reduced
3. Engineering team is investigating an enhanced dust/cuttings removal technique for abraded patch
  - use of compressed gas “puff”?
4. Baselined use of *Procedural Witness Blanks* rather than drilled blank

# Sample Integrity Requirements

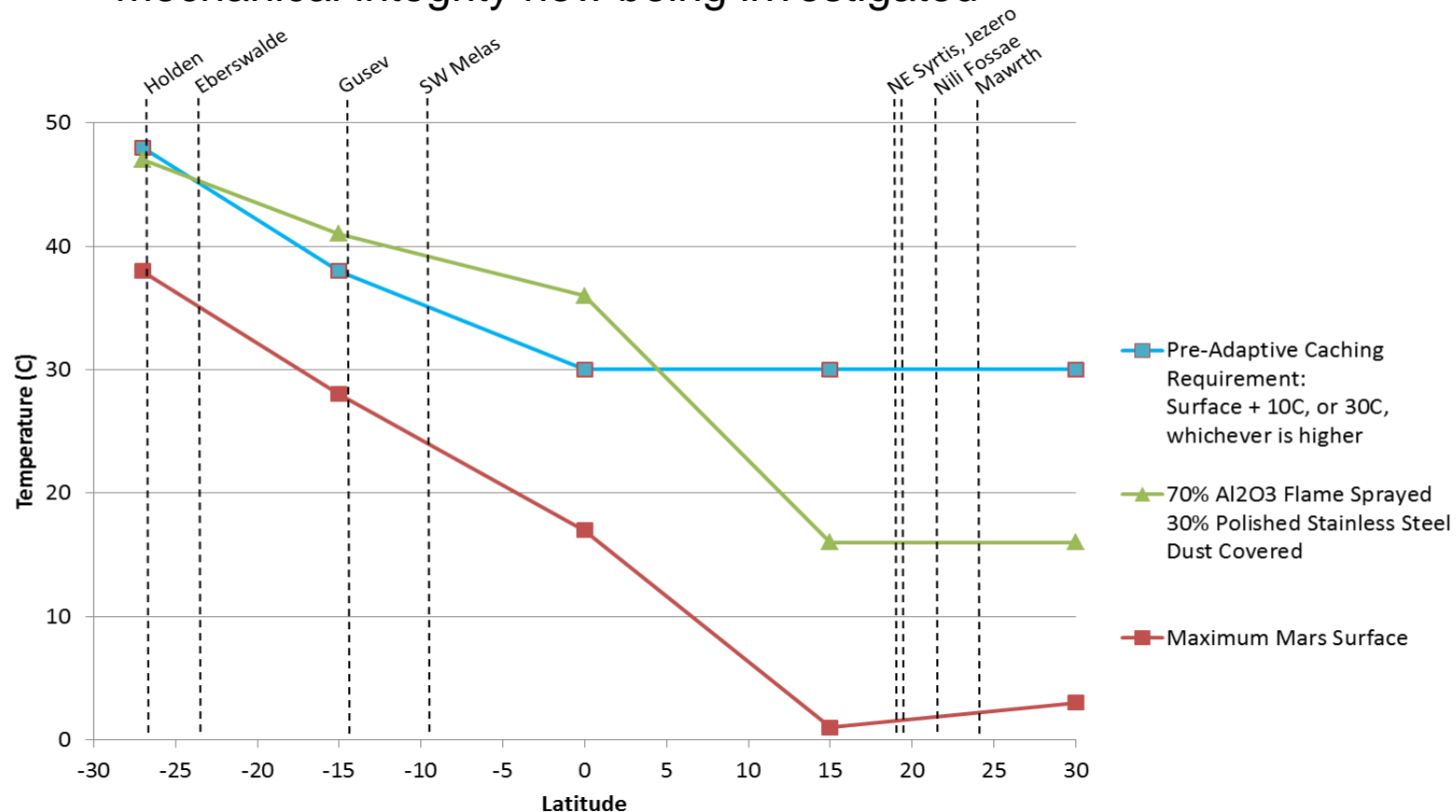


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5. Mitigation strategy developed for sample tube heating after depot caching
- coating of tube with alumina keeps samples below the required level of 60°C at all prioritized landing sites

- mechanical integrity now being investigated



# Landing Site Update



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Last August's Landing Site Workshop:

a) "Fluvial/Deltaic/Lacustrine Sites"

- Eberswalde
- Holden
- Jezero
- SW Melas

b) "Hydrothermal/Crustal/Other Sites"

- Columbia Hills
- NE Syrtis
- Nili Fossae
- Mawrth

*With **TRN baselined** - we now have access to all of these sites!*

*These sites are now being extensively investigated by the project: safety, operability, traversability. Metric: can we acquire sufficient number of samples in prime mission?*

Sites prioritized for further scientific investigation: McLaughlin, Hypanis



# **Project Update**

## **McNamee**

# Mission Overview



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## LAUNCH

- MSL Class/Capability LV
- Period: Jul/Aug 2020

## CRUISE/APPROACH

- 7.5 month cruise
- Arrive Feb 2021

## ENTRY, DESCENT & LANDING

- MSL EDL system ([Range Trigger and TRN baselined](#)): guided entry and powered descent/Sky Crane
- 16 x 14 km landing ellipse (range trigger baselined)
- Access to landing sites  $\pm 30^\circ$  latitude,  $\leq -0.5$  km elevation
- Curiosity-class Rover

## SURFACE MISSION

- 20 km traverse distance capability
- [Enhanced surface productivity](#)
- [Qualified to 1.5 Martian year lifetime](#)
- Seeking signs of past life
- Returnable cache of samples
- Prepare for human exploration of Mars

<http://mars.jpl.nasa.gov/mars2020/>

# Timeline to PDR/KDP-C



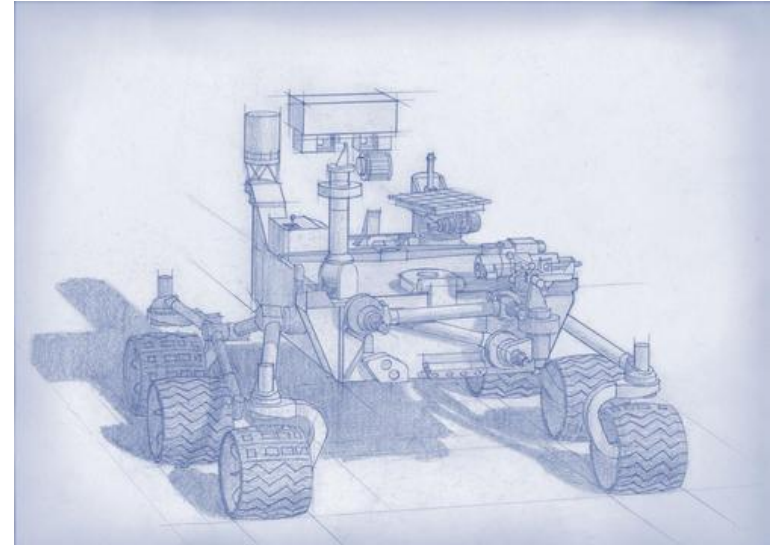
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- |                  |   |                  |                 |
|------------------|---|------------------|-----------------|
| ■ 11-12 Mar 2015 | - Payload (+) Systems Review                            | ■ 6-7 Jan 2016   | - PIXL PDR      |
| ■ 25 Mar 2015    | - JPL KDP-B Center Management Council                   | ■ 20-21 Jan 2016 | - MOXIE PDR     |
| ■ 8 May 2015     | - KDP-B Directorate Program Management Council          | ■ 20-21 Jan 2016 | - Cost Review   |
| ■ 20 May 2015    | - KDP-B Agency Program Management Council               | ■ 2-4 Feb 2016   | - Project PDR   |
| ■ 1 June 2015    | - Phase B start   | ■ 16-17 Feb 2016 | - SHERLOC PDR   |
| ■ 2-3 June 2015  | - Flight System Baseline Workshop #2                    | ■ 24 Feb 2016    | - KDP-C CMC     |
| ■ 9 June 2015    | - Sampling and Caching System Final Architecture Review | ■ Mar 2016       | - KDP-C DPMC    |
|                  |   | ■ Apr 2016       | - KDP-C APMC    |
|                  |   | ■ Apr/May 2016   | - Phase C Start |
| ■ 4-6 Aug 2015   | - 2 <sup>nd</sup> Landing Site Workshop                 |                  |                 |
| ■ 25-26 Aug 2015 | - EDL PDR   |                  |                 |
| ■ 15-16 Sep 2015 | - FS Heritage Review                                    |                  |                 |
| ■ 24-25 Sep 2015 | - RIMFAX PDR  |                  |                 |
| ■ 1 Oct 2015     | - PP Implementation Review #2                           |                  |                 |
| ■ 15-16 Oct 2015 | - Supercam PDR  |                  |                 |
| ■ 28-29 Oct 2015 | - Mastcam-Z PDR   |                  |                 |
| ■ 5-6 Nov 2015   | - MEDA PDR  |                  |                 |
| ■ 10-11 Nov 2015 | - TRN PDR   |                  |                 |
| ■ 17-18 Nov 2015 | - SCS PDR   |                  |                 |
| ■ 3-4 Dec 2015   | - Surface Phase PDR                                     |                  |                 |

## **Salient Features**

- *Category: 1*
- *Risk Class: B*
- *Directed, JPL in-house implementation*
- *High heritage MSL design*
- *Modifications only as necessary to accommodate new payload and Sampling / Caching System (SCS)*
- *Planetary Protection Category V per Level 1 Requirements*



## **Science**

- *Assess past habitability of an astrobiologically relevant ancient environment on Mars*
- *Assess biosignature preservation potential with the environment and search for biosignatures*
- *Assemble cached samples for possible future return to Earth*
- *Provide an opportunity for contributed HEO/STMD participation to advance technologies with potential applications to future human exploration objectives*

# Spacecraft Build Approach



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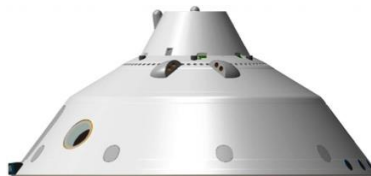
## Launch Vehicle

- KSC/Launch Services Program procurement



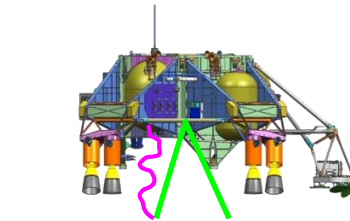
## MMRTG

- DoE procurement to industry



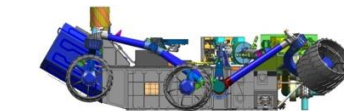
## Science & Exploration Technology Investigations

- Source per proposals via AO selection



## MEDLI

- NASA Centers (LaRC, ARC, and JPL)



- Built in-house at JPL
- Lowest cost and risk per make-buy study and industry RFIs

- Built by Lockheed-Martin/Denver
- Procure as sole source—most cost effective

- Built in-house at JPL
- Major industry subcontracts/components
- Rebuild in-house due to criticality of EDL and rover interface

- Built in-house at JPL
- Major industry subcontracts/components
- Spanish contributed High Gain Antenna
- Rebuild in-house due to complexity of vehicle, residual hardware, criticality of EDL and rover interface, operations experience

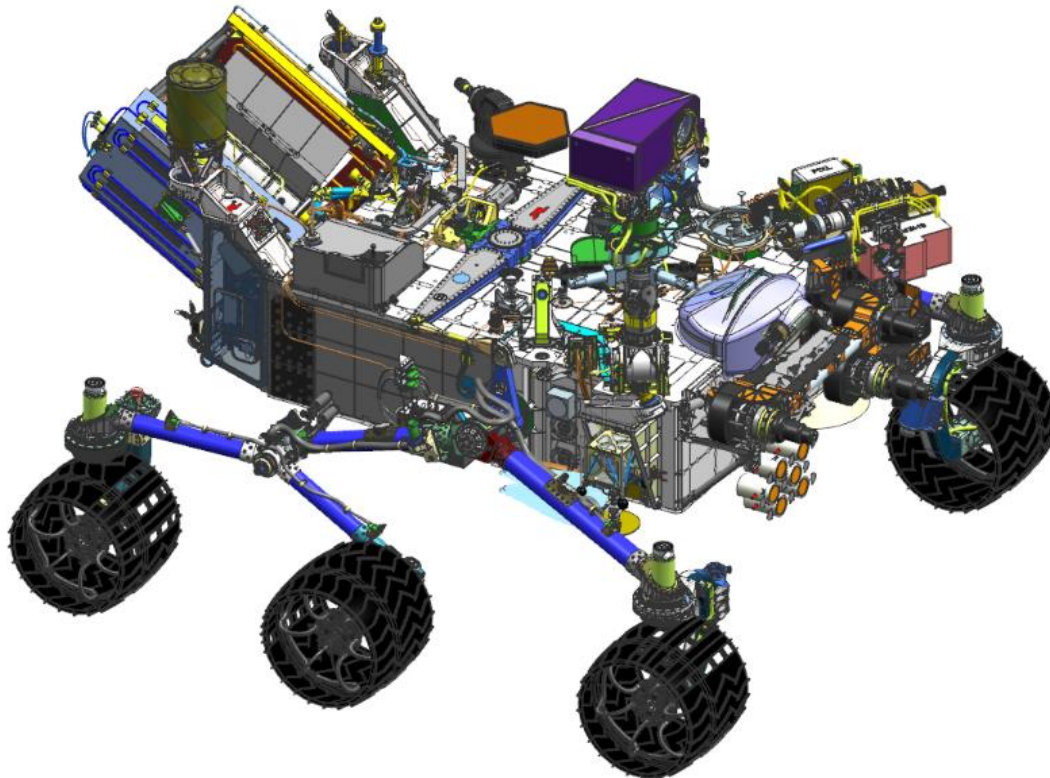
- Built by Lockheed-Martin/Denver
- Procure as sole source—most cost effective

# Mars 2020 Rover Concept



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## Stays the Same as MSL

- Avionics
- Power
- GN&C
- Telecom
- Thermal
- Mobility

## Changed

- New Science Instrument Suite
- New Sampling Caching System
- Modified Chassis
- Modified Rover Harness
- Modified Surface FSW
- Modified Rover Motor Controller
- Modified Wheels

## Expected to Change

- Some Mobility components (to support wheel and/or Rover mass)

## SMD Directed Study Status

■ Terrain Relative Navigation:	BASELINED BY PROJECT – DIRECTION FORTHCOMING
■ Turret Imaging Upgrade:	BASELINED
■ Helicopter:	SUPPORT ACCOMMODATION STUDY
■ Cubesats:	ELIMINATED FROM CONSIDERATION
■ Microphone:	BASELINED WITH EDL CAMERAS
■ Ringsail Parachute:	ELIMINATED FROM CONSIDERATION
■ EDL Cameras	BASELINED

## Program / Project Initiated Studies

■ Adaptive Cache Approach:	BASELINED
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# Project Summary and Conclusions



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- The Mars 2020 Project has conducted successfully the lower level instrument, subsystem, and Office level PDR's necessary to provide confidence in a full understanding of the requirements, design response, and associated cost estimates
- SHERLOC issues have been identified and action taken. A full and successful PDR was conducted Feb. 16-17
- Cost performance on heritage HW continues to perform under plan
- Cost estimates for new developments, particularly the instrument payload and SCS, are believed to provide acceptable financial and schedule margins that support a 2020 launch within the estimated A thru D cost target